

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of)
)
Update to Parts 2 and 25 Concerning Non-) IB Docket No. 16-408
Geostationary, Fixed-Satellite Service Systems)
and Related Matters)

To: The Commission

**COMMENTS OF
THE BOEING COMPANY**

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SUMMARY

The Boeing Company (“Boeing”) supports the adoption of rules and policies that encourage and facilitate the operation of large NGSO FSS systems, which will be critical to close the broadband digital divide in the United States and globally. To this end, the Commission should avoid imposing excessive or unnecessary regulations absent a clear showing that large NGSO FSS systems present a risk of interference to incumbent spectrum uses. In most cases, the frequency bands at issue can support operations of both GSO and NGSO FSS systems on a shared and complementary basis. With respect to the specific issues raised in the NPRM, Boeing advocates the following major issues.

- The Commission should restore the secondary allocation to the FSS in the 17.8-18.3 GHz band, but given the ability of satellite earth stations to receive signals in this spectrum on an opportunistic basis, the Commission should authorize such earth stations through a blanket licensing approach.
- The Commission should permit NGSO FSS systems to operate on an unprotected basis with respect to GSO FSS networks in the 18.3-18.6 GHz and 19.7-20.2 GHz bands.
- The Commission should allow GSO FSS operations in the 18.8-19.3 GHz downlink band on an unprotected, non-interference basis with respect to NGSO FSS systems and paired with the current secondary GSO FSS designation in the 28.6-29.1 GHz band. The Commission, however, should not consider elevating GSO FSS to co-primary status in the 18.8-19.3 GHz and 28.6-29.1 GHz bands.
- The Commission should allow both GSO and NGSO FSS systems to operate in the 19.3-19.4 GHz, 19.6-19.7 GHz, and 29.3-29.5 GHz bands, but the Commission should designate NGSO FSS as having priority over GSO FSS in this spectrum consistent with the existing NGSO MSS allocation in these frequency bands.
- The Commission should work with the satellite industry to identify and adopt EPFD limits for NGSO FSS downlink operations in the 17.8-18.6 GHz and 18.8-19.7 GHz bands. Boeing, however, could not support the codification of a rule requiring that the aggregate PFD produced by a constellation of Ka-band satellites at any point in the Earth’s surface cannot exceed -115 (dBW/m²)/MHz because such a limit would seriously inhibit the ability of NGSO constellations to deliver broadband service to relatively small, low-cost end user terminals.

- The Commission should codify the EPFD limits that exist in ITU Radio Regulations Article 22 and Resolution 76 (Rev.WRC-15) for NGSO FSS systems operating in the Ka-band. It may not be appropriate, however, to import all of the compliance measures that the Commission adopted for NGSO FSS systems operating into the Ku-band into its rules for Ka-band NGSO FSS systems.
- The Commission should eliminate Section 25.156(d)(5) of the Commission's rules, but it should not be replaced with a default presumption that GSO FSS systems have priority over NGSO FSS systems in all frequency bands lacking service rules. The Commission has recognized that NGSO FSS systems require access to some FSS spectrum on a priority basis to ensure service to consumers.
- The Commission should extend its inline avoidance rule to NGSO FSS systems operating in other frequency bands allocated for FSS including the Ka-band and the V-band. The Commission, however, should not codify a separation angle of 10 degrees as the appropriate criteria for interference avoidance for all possible NGSO systems and frequency bands, or require band splitting as the appropriate response to an inline event. Further, the Commission should eliminate its band-splitting rule (Sections 25.157(e)) since it arguably conflicts with the in-line avoidance rule.
- The Commission should not adopt default EIRP limits on earth stations operating with NGSO FSS systems because it may constrain current technological development. The Commission should also refrain from adopting downlink power limits and earth station receive gain criteria for NGSO FSS systems.
- The Commission should revise its milestone requirements to reflect the practical realities of launching very large NGSO FSS constellations, which will likely take place on a multi-phased basis. Rather than identifying an arbitrary minimum threshold for the percentage or number of satellites that are sufficient to satisfy the sixth year milestone, the Commission should permit NGSO system applicants to identify a reasonable number for milestone compliance relative to their proposed system. The Commission should also allow an additional six years for the launch of the remainder of a large NGSO constellation.
- Finally the Commission should eliminate its global coverage requirement for NGSO FSS systems given the documented ability of NGSO FSS systems to share spectrum with other services, including other NGSO FSS networks.

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The Boeing Company (“Boeing”) provides these comments in response to the Commission’s Notice of Proposed Rulemaking (“*NPRM*”) examining rules and policies governing the operation of large non-geostationary satellite orbit (“NGSO”) satellite systems operating in the fixed-satellite service (“FSS”).¹

Boeing seeks to launch and operate two large NGSO FSS systems to provide broadband services to consumers, one that will operate in the Ka-band and another that will operate in the V-band. Boeing is a world leading manufacturer of geostationary (“GSO”) satellites. More than two dozen of Boeing’s flagship 702 spacecraft are currently operating in space, with more than a dozen more 702 spacecraft currently in production. In 2014, Boeing also introduced its 502 spacecraft, providing an option to customers that desire a smaller spacecraft. Boeing therefore has a very strong interest in the issues addressed in the *NPRM*.

Throughout this proceeding, Boeing urges the Commission to recognize the critical opportunity that is presented through the operation of large NGSO FSS systems on a shared and

¹ See Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters, IB Docket No 16-408, *Notice of Proposed Rulemaking*, FCC 16-170 (Dec. 15, 2016) (“*NPRM*”).

complementary basis with GSO and other NGSO FSS systems. Such satellite networks can expeditiously bridge the digital divide by providing very high data rate communications services to all populations regardless of their location. NGSO FSS systems can also provide backhaul to support the expansion of terrestrial networks. Thus, the Commission should adopt rules and policies that encourage and facilitate the launch of a wide range of NGSO FSS systems, rather than imposing excessive and overly restrictive regulations that may not serve a legitimate purpose in facilitating spectrum sharing between NGSO FSS systems and other satellite and terrestrial-based users of spectrum resources.

I. THE COMMISSION SHOULD AUTHORIZE FSS OPERATIONS IN THE 17.8-18.3 GHZ BAND ON A SECONDARY BASIS USING BLANKET-LICENSED EARTH STATIONS

Boeing supports the Commission's proposal to restore the secondary allocation to the FSS in the 17.8-18.3 GHz band.² FSS networks already operate successfully in this spectrum without causing harmful interference to the Fixed Service ("FS"). As the *NPRM* notes, the International Bureau has previously authorized O3b Limited ("O3b") to operate its NGSO network and associated earth stations in this frequency band on a non-conforming basis.³ The Commission is also considering the numerous applications of other satellite system operators, including Worldvu and Boeing.

Protecting FS operations in this spectrum would not be difficult. Non-federal terrestrial use of this frequency band appears modest. According to the FCC's Universal Licensing System, FS systems consist primarily of Common Carrier Fixed Point to Point Links (about 1440

² See *id.*, ¶ 9.

³ See Application of O3b Limited, File No. SAT-LOI-20141029-00118 (granted Jan. 22, 2015) ("*June 2015 O3b Grant*") (authorized for operations in the 17.8-18.6 GHz range).

licenses), as well as Microwave Industrial/Business Pool (about 538 licenses) and Microwave Public Safety Pool (about 412 licenses). Further, the customary configurations of FS networks help to facilitate spectrum sharing. FS links typically operate in a horizontal or low elevation angle relative to the horizon, using narrow beam antennas. In contrast, most NGSO FSS systems transmit to user terminals from much higher elevation angles. Given the highly directional nature of the FS antennas in this frequency band, sufficient sidelobe isolation, typically in excess of 28 to 30 dB, would be available to ensure that FS links operating co-frequency in the 17.8-18.3 GHz band with NGSO downlinks at the authorized PFD limits would experience very limited and transient interference impacts relative to their operational noise floor.

Because of the significant opportunities for spectrum sharing, no reason exists to limit FSS operations in this spectrum to individually-licensed earth stations. Satellite earth stations will not transmit in this spectrum, they will only receive signals. Therefore, satellite earth stations cannot cause interference to FS networks regardless of where they are physically located.

With respect to protecting satellite earth stations, an individual licensing approach facilitates spectrum sharing only when site-based coordination is employed, which would not be the case in the 17.8-18.3 GHz band. Instead, the Commission is proposing to allow satellite earth stations to operate in this spectrum on a secondary, opportunistic basis. Such an approach will depend primarily on dynamic methods employed by satellite system operators to avoid interference, such as using minimum operational elevation angles, selectively increasing satellite power (within PFD limits), assigning earth stations to alternative frequency channels or satellites, applying earth station shielding, or any combination thereof.

In fact, an individual licensing approach would impede the use of dynamic measures to avoid FS interference, such as necessitating the filing of a license modification application before

an earth station is moved to a different location where natural shielding may fully address an individual case of interference. Therefore, the Commission should authorize satellite earth stations to operate in the 17.8-18.3 GHz band on a secondary, opportunistic basis using a blanket license approach.

II. THE COMMISSION SHOULD AUTHORIZE SECONDARY NGSO FSS OPERATIONS IN THE 18.3-18.6 GHZ AND 19.7-20.2 GHZ BANDS

Boeing supports the Commission's proposal to allow NGSO FSS systems to operate on an unprotected basis with respect to GSO FSS networks in the 18.3-18.6 GHz and 19.7-20.2 GHz bands.⁴ As the NPRM acknowledges, the Commission has successfully allowed other NGSO FSS systems to use all or portions of this spectrum.⁵

NGSO FSS systems can use GSO arc avoidance to comply with ITU limits and protect GSO FSS systems. This constraint is typically implemented by inhibiting transmissions from all NGSO system satellites within a "GSO protection zone" that is centered on the equator relative to the sub-satellite orbital path. Prior to entry of an NGSO satellite into the GSO protection zone, NGSO system operations center would "hand-over" the affected user terminals to alternate satellites within their field of view, ensuring uninterrupted service to all users.

Implementation of the GSO protection zone described above also has the effect of mitigating interference into earth stations, both gateways and user terminals, caused by GSO satellites. Prior to entry of an NGSO satellite into the protection zone, all user terminals being served by that satellite would be handed over to alternate satellites that have a greater separation angle from the GSO arc.

⁴ See NPRM, ¶ 10.

⁵ For example, the IB granted waiver of NG164 in the 18.3-18.6 GHz band to O3b when it demonstrated that its proposed non-conforming use would not cause harmful interference to present or future users of the frequency bands.

The gateway that is receiving downlink signals from the NGSO satellite entering the protection zone would be re-tasked, making it available to serve other satellites as they enter its field of view, again at greater separation angles from the GSO arc.

Through the use of these and similar techniques, NGSO FSS systems can share the 18.3-18.6 GHz and 19.7-20.2 GHz bands with GSO FSS systems and the Commission should therefore authorize such use subject to protecting GSO FSS networks.

III. THE COMMISSION SHOULD LIMIT BOTH THE OPERATION AND REGULATORY STATUS OF GSO FSS SYSTEMS TO AN UNPROTECTED, NON-INTERFERENCE BASIS IN THE 18.8-19.3 GHZ BAND

Boeing does not object to allowing GSO FSS operations in the 18.8-19.3 GHz downlink band on an unprotected, non-interference basis with respect to NGSO FSS systems and paired with the current secondary GSO FSS designation in the 28.6-29.1 GHz band.⁶ The Commission, however, should not consider elevating GSO FSS to co-primary status in the 18.8-19.3 GHz and 28.6-29.1 GHz bands.⁷ Pursuant to ITU Radio Regulation (“RR”) No. 22.2, GSO FSS systems have operational priority over NGSO FSS systems in the vast majority of frequency bands allocated to FSS. It is therefore important to preserve some FSS frequency bands as having priority for NGSO systems. Boeing acknowledges that NGSO and GSO FSS systems are subject to coordination on an international basis pursuant to RR No. 9.11A. Nevertheless, the Commission’s regulations significantly influence the international coordination process and therefore it remains important for the Commission to maintain priority for NGSO FSS systems in some frequency bands, including in the 18.8-19.3 GHz and 28.6-29.1 GHz bands.

⁶ See *NPRM*, ¶ 11.

⁷ See *id.*, ¶ 12.

IV. THE COMMISSION SHOULD AUTHORIZE FSS IN THE 19.3-19.4 GHZ, 19.6-19.7 GHZ, AND 29.3-29.5 GHZ BANDS, BUT NGSO FSS SYSTEMS SHOULD HAVE PRIORITY OVER GSO FSS SYSTEMS IN THIS SPECTRUM

Boeing supports the Commission's proposal to allow both GSO and NGSO FSS systems to operate in the 19.3-19.4 GHz, 19.6-19.7 GHz, and 29.3-29.5 GHz bands, which are currently designated for, but unused by, the mobile-satellite service ("MSS") for feeder links.⁸ This said, Boeing has proposed to operate an NGSO satellite system that would use this spectrum for feeder links to support both FSS and MSS services. Boeing therefore cannot support the Commission's proposal to authorize NGSO FSS systems on an unprotected basis with respect to GSO FSS systems.

With respect to the downlink spectrum, internationally this spectrum remains limited to NGSO MSS feeder links.⁹ Since Boeing would operate in both services, this means that its NGSO MSS feeder link operations would be protected by GSO FSS systems, but its NGSO FSS operations would be unprotected. Such an approach would seem impractical and not justified by the brief discussion on the issue that is included in the *NPRM*. With respect to the uplink spectrum, internationally GSO FSS and NGSO MSS feeder links are co-primary.¹⁰ Therefore, NGSO systems operating in both the FSS and MSS services would be co-primary with respect to their MSS operations, but secondary with respect to their FSS operations. Here again, this approach would be impractical and not justified.

Instead, with respect to the downlink spectrum, the Commission should reverse its proposed priorities and designate NGSO FSS as having priority over GSO FSS. With respect to

⁸ *See id.*, ¶ 13.

⁹ *See, e.g.*, ITU Radio Regulations ("RR") No. 5.523B.

¹⁰ *See* RR No. 5.535A.

the uplink spectrum, the Commission should make all GSO and NGSO operations co-primary using rules similar to those that already exist to allow sharing between GSO FSS and NGSO MSS feeder links. This approach would clearly delineate the regulatory hierarchy that would exist between GSO and NGSO systems without attempting to differentiate between the types of services provided by the NGSO network.

V. THE COMMISSION SHOULD CONTINUE TO MAINTAIN ITS FSS FREQUENCY LIST IN PART 25 WITH APPROPRIATE UPDATES

Boeing questions the apparent proposal in the NPRM to eliminate the table in Section 25.202(a) listing the frequency bands that are available for FSS.¹¹ Boeing believes that this table provides a convenient resource to quickly ascertain the frequency bands that are covered by Part 25 of the Commission's rules. Boeing observes that similar lists of available frequencies are included in other Parts of the Commission's rules including those for Broadband PCS (24.229), Miscellaneous Wireless Communications Services (27.5), UMFUS (30.4), Broadcast Auxiliary Stations (74.402, 74.502, 74.602, 74.802, and 74.1202), Maritime (80.351-80.393), Aviation (87.41), and Private Land Mobile Radio Services (90.303, 90.311, 90.377, 90.613, and 90.715). Thus, there does not seem to be a reason to remove this list from Section 25.202(a). Instead, the Commission should update the list and continue to update it as necessary in the future.

¹¹ See NPRM, ¶ 14.

VI. THE COMMISSION SHOULD ADOPT POWER LIMITS FOR NGSO FSS SYSTEMS IN THE 17.8-18.6 GHZ AND 18.8-19.7 GHZ BANDS

Boeing supports creating power limits for NGSO FSS downlink operations in these frequency bands.¹² Boeing has already indicated in its NGSO Ka-band application that it will comply with the Section 25.208(e) limits across each of these frequency bands. Boeing recognizes that the current PFD limits that exist in Section 25.208(e) may have been derived based on assumptions involving smaller NGSO constellations, albeit not smaller than the 60 satellite constellation that Boeing has proposed to launch and operate in the Ka-band. Nevertheless, Boeing supports the development of EPFD limits for NGSO FSS operations in these frequency bands. Boeing recommends that the Commission work with interested parties within the satellite industry to identify appropriate EPFD limits that could be included in the Commission's rules.

Boeing, however, cannot support the codification of a rule requiring that the aggregate PFD produced by a constellation of Ka-band satellites at any point in the Earth's surface cannot exceed -115 (dBW/m²)/MHz because this would be excessively and unnecessarily burdensome to NGSO FSS systems. One of the major goals of many proposed NGSO FSS satellite systems is to enable the provision of broadband service to a global population using relatively small, low-cost terminals. In order for an NGSO FSS system to support small terminal sizes (for example, 0.3-0.5 meter aperture sizes, with G/T performance of 7-11 dB/K), a downlink PFD of at least -110 dBW/m²/MHz will be required to provide broadband services with high availability in the Ka-band. Creating a *de facto* limit on the aggregate PFD of a NGSO constellation will

¹² See *id.*, ¶¶ 15-16.

unnecessarily limit the broadband services and terminal sizes available from even a single NGSO FSS satellite and significantly constrain the design and/or performance of the entire constellation.

Boeing recommends the Commission use the more appropriate approach of performing EPFD analyses of the proposed NGSO constellations using reference NGSO receive terminals. Such EPFD analyses can incorporate multiple angles of arrival and can use end user terminal receive antenna patterns, which are reflective of actual interference conditions expected to be encountered during system operation.

VII. THE COMMISSION SHOULD REFRAIN FROM EXTENDING ITS COMPLIANCE SHOWING FOR KU-BAND NGSO FSS SYSTEMS TO NGSO FSS SYSTEMS IN THE KA-BAND WITHOUT FURTHER STUDY

Boeing has no objection to the Commission's proposal to incorporate into its rules the EPFD limits that exist in RR Article 22 and Resolution 76 (Rev.WRC-15) for NGSO FSS systems operating in the Ka-band.¹³ As Boeing indicated in its application for authority to launch and operate an NGSO system in the Ka-band, Boeing's NGSO system would comply with the EPFD limits and therefore adequately protect GSO FSS networks.

Boeing is concerned, however, about the Commission's proposal to import all of the compliance measures that exist for NGSO FSS systems operating in the Ku-band into its rules for NGSO FSS systems operating in the Ka-band.¹⁴ As the Commission is aware, the compliance measures that were mandated for NGSO FSS systems in the Ku-band were developed in recognition that the Ku-band was a very mature spectrum band, with a wide variety of legacy incumbent users operating in the band to provide various services, such as highly sensitive Direct Broadcast Satellite services. Therefore, extremely detailed and arguably

¹³ See *id.*, ¶¶ 18-19.

¹⁴ See *id.*, ¶ 19.

burdensome measures were deemed necessary to ensure that any newly-introduced NGSO FSS systems in the Ku-band would not cause unacceptable levels of interference to legacy systems.

In stark contrast, the deployment of satellite and terrestrial systems in the Ka-band has been much more recent and has involved the use of more modern technologies that are arguably more resilient in their ability to share spectrum with other systems. Therefore, Boeing does not believe that the Commission can necessarily assume that the same regulatory compliance showings that may have been justified for use in the Ku-band are automatically justified for use in the Ka-band. Instead, Boeing recommends that the Commission reach out to the satellite industry, potentially through the Satellite Industry Association, to create a taskforce of technical experts that could study the issue and determine which of the compliance showings that were mandated for NGSO FSS systems in the Ku-band may be sufficiently warranted for use in the Ka-band. Boeing would welcome the opportunity to participate in such an analysis.

VIII. THE COMMISSION SHOULD UPDATE ITS RULES FOR GSO/NGSO PRIORITY, BUT NOT BY GIVING GSO NETWORKS PRIORITY IN EVERY FUTURE FSS SPECTRUM BAND

As the NPRM acknowledges, Section 25.156(d)(5) of the Commission's rules indicates that once a license is issued for a GSO or NGSO system in a particular frequency band that lacks service rules, the FCC will not issue a license for systems in the other service until service rules are adopted.¹⁵ The Commission's rule is consistent with the Commission's statement in its 2003 satellite licensing reform proceeding that, when no service rules exist for sharing between

¹⁵ See *id.*, ¶ 21.

GSO and NGSO systems in a particular frequency band, FCC will only consider applications of the type (GSO or NGSO) that is filed first.¹⁶

Boeing agrees that both of these restrictions have outlived their usefulness. It is now clear that GSO and NGSO systems can share spectrum on a co-frequency basis using various techniques. Therefore, a prohibition on their joint operation is unnecessary.

Boeing, however, does not support a default conclusion that GSO systems in the United States should always have priority over NGSO systems. The Commission has recognized on multiple occasions that NGSO systems need access to sufficient FSS spectrum to provide services without necessarily having to protect GSO networks. Such dedicated NGSO FSS spectrum is particularly important to ensure uninterrupted service to regions near the equator, where the persistent broadband digital divide is particularly acute. For example, the Commission identified certain Ka-band frequencies as primarily available for NGSO FSS systems. The Commission also concluded that certain V-band spectrum should be designated as primarily for NGSO FSS use.¹⁷ The Commission, however, held off on determining how much V-band spectrum should be made primarily available for NGSO FSS systems until proposals for V-band satellite networks became more mature.¹⁸

¹⁶ See Amendment of the Commission's Space Station Licensing Rules and Policies, *First Report and Order and Further Notice of Proposed Rulemaking*, 18 FCC Rcd 10760, 10786-87, ¶ 58 (2003).

¹⁷ See Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz, and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations, FCC 98-336, *Report and Order*, ¶ 22 (Dec. 23, 1998).

¹⁸ See *id.*

Given this long standing recognition by the Commission of the need for FSS allocations that are primarily for NGSO use, the Commission should not create a default sharing rule modeled after RR No. 22.2 that would require NGSO systems to always protect GSO systems. Such a default rule would make it much more difficult for NGSO system operators to work with the Commission and the rest of the satellite industry to identify frequency bands that should primarily be available for NGSO use. Instead, the Commission should conclude that, in those FSS frequency bands where service rules have not been adopted, no presumption exists regarding whether GSO or NGSO FSS networks will have sharing priority in that spectrum.

IX. THE COMMISSION SHOULD EXPAND ITS IN-LINE AVOIDANCE RULE TO OTHER SPECTRUM BANDS, BUT NOT NECESSARILY WITH A SEPARATION ANGLE OF 10 DEGREES

Boeing supports the Commission's proposal to extend its inline avoidance rule to NGSO FSS systems operating in other frequency bands allocated for FSS including the Ka-band and the V-band.¹⁹ In doing so, however, the Commission should not codify a separation angle of 10 degrees as the appropriate criteria for interference avoidance for all possible NGSO systems and frequency bands. NGSO FSS systems operating in higher frequency bands, particularly the V-band, may generally operate with much narrower beams and better discrimination. Such systems may be able to share spectrum with other NGSO systems using avoidance angles that are smaller than 10 degrees or using some other criteria to avoid interference.

Therefore, although the Commission should codify its in-line avoidance rule for all NGSO FSS systems regardless of frequency band, the Commission should identify the specific avoidance criteria to be used for each frequency band using a public notice and comment process that should be conducted shortly after the NGSO cut-off deadline for each major frequency band.

¹⁹ See *NPRM*, ¶¶ 22-23.

This will allow NGSO FSS license applicants to work with the Commission to identify an appropriate interference event criteria based on the characteristics of the NGSO systems that are identified in the license applications that were filed in response to the cut-off notice. Obviously, for the Ka-band, the NGSO FSS cut-off deadline has already passed and the identification of appropriate interference avoidance criteria is ripe for consideration by NGSO FSS system applicants and the Commission. With respect to the V-band, the cut-off deadline is imminent.

In extending its in-line avoidance rule to additional frequency bands, the Commission should not automatically require that different NGSO FSS systems sharing the same spectrum employ a band splitting approach to address an in-line conflict. Instead, other less burdensome measures may be available involving the use of satellite or earth station diversity, different polarizations, coding, or other means. The Commission's rules should reflect this by acknowledging that NGSO FSS systems faced with in-line events can employ band splitting or other technical or operational means to address a sharing conflict.

Finally, the Commission should impose its spectrum sharing requirements only on NGSO FSS systems that receive their licensees (or market access grants) pursuant to the same processing round, or were issued licenses at an earlier date without being subject to a processing round. The Commission, however, should not require NGSO FSS systems to use the in-line avoidance approach or other spectrum sharing measures to protect NGSO FSS systems licensed pursuant to subsequent processing rounds. Instead, those later systems should be required to operate on a non-interference and unprotected basis as compared to previously licensed NGSO FSS systems.

In adopting its in-line avoidance approach for NGSO FSS systems, the Commission should also eliminate the band-splitting rule (Sections 25.157(e)) since it arguably conflicts with

the in-line avoidance rule. Specifically, Section 25.157(e) of the Commission's rules, as recently revised by the Commission's Second Order on Reconsideration,²⁰ indicates that, in cases where multiple NGSO FSS systems are granted licenses in the same processing round and insufficient spectrum is available to meet the needs of each licensee, the Commission will divide the available spectrum among them. A licensing process that divides scarce spectrum resources between multiple NGSO FSS system licensees would prevent any of those satellite systems from having access to enough spectrum to provide broadband services that satisfy or exceed the Commission's stated goals for broadband throughput (*i.e.*, 25 Mbps down and 3 Mbps up). Instead, through the use of the in-line avoidance approach and other sharing measures, modern NGSO FSS systems can operate on a co-frequency basis with other NGSO FSS systems and thereby avoid the need for highly inefficient and counterproductive spectrum segmentation.

An additional reason to eliminate the band-splitting approach of Section 25.157(e) is because it inadvertently encourages speculation and arbitrage in NGSO FSS satellite system licenses. Pursuant to the band-segmentation approach of Section 25.157(e), each additional applicant for an NGSO FSS system in a particular frequency band substantially reduces the amount of spectrum that would be available to other NGSO FSS system applicants, potentially (and likely) precluding their construction and launch. In contrast, pursuant to the Commission's in-line avoidance approach to spectrum sharing, each applicant for an NGSO FSS system license in a particular frequency band places no automatic impediment on the plans of other NGSO FSS system applicants in the same spectrum band because each applicant knows that it will be expected to share spectrum on a co-frequency basis with other systems that are

²⁰ See Amendment of the Commission's Space Station Licensing Rules and Policies, IB Docket No. 02-34, *Second Order on Reconsideration*, FCC 16-108 (Aug. 16, 2016).

actually launched. Therefore, the Commission should eliminate the band segmentation requirements of Section 25.157(e) to discourage speculation and arbitrage in NGSO system licenses.

X. THE REQUIREMENT FOR PUBLICATION OF EPHEMERIS DATA SHOULD BE EXTENDED TO ADDITIONAL SPECTRUM BANDS AND ALLOW CHOICE OF DATA PUBLICATION OR EXCHANGE METHODS

Boeing supports the Commission's proposal to extend to the Ka-band its requirement that NGSO FSS systems must publish ephemeris data to facilitate coordination with other systems.²¹ Boeing believes that, in most cases, the current requirement that the ephemeris data must be updated every three days is sufficient. The Commission should also permit satellite operators to decide how to electronically publish their data, rather than mandating participation in the Space Data Association or requiring data submissions to the U.S. Strategic Command's Joint Space Operations Center (unless otherwise required by applicable use-of-space regulations).

XI. THE COMMISSION SHOULD REFRAIN AT THIS TIME FROM MANDATING EARTH STATION TRANSMIT EIRP DENSITY LIMITS OR RECEIVE GAIN CAPABILITIES

Boeing acknowledges that limiting the amount of off-axis energy from earth stations communicating in the uplink direction to NGSO satellites could facilitate frequency sharing among NGSO FSS systems by reducing the required angular separation between co-frequency constellations.²² Boeing believes, however, that NGSO FSS system operators already have sufficient incentive to limit the off-axis emissions from their earth stations in order to avoid intra-system interference into their own satellites. Therefore, Boeing believes that it is

²¹ See *NPRM*, ¶¶ 24-25.

²² See *id.*, ¶¶ 28-30.

premature to adopt default EIRP limits on earth stations operating within NGSO FSS systems. The satellite industry is currently in a tremendous state of development with respect to NGSO system technologies and the adoption of fixed limits at this time could easily impair this growth and innovation. Boeing is particularly concerned about the Commission's apparent proposal to base such EIRP limits on those employed for the two degree spacing environment of GSO satellite systems. Boeing acknowledges that the Commission adopted such limits for earth stations operating with O3b's NGSO FSS network, but the O3b system involves earth station terminals that may generally be larger than those that are being developed for other NGSO services that are focused more on the direct-to-end user business case. As described previously, many NGSO FSS systems are being designed to enable proliferation of smaller end user devices to more readily enable low-cost broadband access. Any off-axis limits must take into account the different range of terminals sizes used for NGSO versus GSO FSS services.

For largely these same reasons, Boeing also does not support the Commission's proposal to adopt downlink power limits and earth station receive gain criteria for NGSO FSS systems.²³ Here again, NGSO FSS system operators already have adequate incentive to optimize such capabilities for their own purposes. Similarly, the small terminal sizes discussed above need off-axis sidelobe requirements that are appropriate for the range of services contemplated by operators of NGSO FS systems. Likewise, the development of appropriate EPFD regulations for NGSO-GSO and NGSO-NGSO spectrum sharing should include the assumed reference terminal off-axis gain requirements. The Commission should therefore allow the satellite industry to continue its development of NGSO FSS system technologies and refrain from adopting such technical requirements for earth stations until EPFD regulations are more firmly

²³ See *id.*, ¶ 30.

understood, and only if it becomes clear that restrictions on earth station performance is necessary to address interference concerns.

XII. THE COMMISSION SHOULD REVISE ITS MILESTONE RULES TO REFLECT THE REALITIES OF VERY LARGE NGSO SYSTEMS

Boeing fully supports the Commission in its proposal to eliminate the unnecessary requirement that NGSO system licensees be required to launch their entire constellation in order to demonstrate compliance with their milestone requirements.²⁴ As the recent NGSO system proposals of Boeing and others demonstrate, large NGSO systems are likely to be deployed in stages, with an initial constellation that is sufficient to provide service to an introductory customer base and additional satellites added to respond to increased capacity requirements.

Given the realities of this approach, it would be highly inefficient to require NGSO system operators to launch all, or even most, of their satellites before they are needed to serve consumers. Each satellite has a finite lifetime and, as a result, satellites that are launched prior to their need would increase the cost of the satellite system, without any corresponding benefit. Launching satellites in advance of when they are needed would also unnecessarily increase the constellation management requirements and the environmental impact of such launches without any corresponding benefit. Instead, the Commission should only require that the launch and initiation of operation of sufficient satellites to satisfy the operator's initial business plans.

In this respect, a requirement to launch 75 percent, or, in some cases, even 50 percent of the proposed total constellation would be arbitrary and arguably unnecessary. Instead, the Commission should recognize that the underlying purpose of its milestone rules is "to deter warehousing by satellite operators before a proposed space station has been launched and begun

²⁴ See *id.*, ¶¶ 31-33.

operations.”²⁵ This goal can be satisfied using a regulatory approach that is far more flexible and accommodating for large NGSO system operators.

For example, rather than require the launch of an arbitrary percentage of a constellation by the sixth year milestone, the Commission should permit NGSO system applicants to indicate in their applications how many satellites they will require to satisfy their initial business requirements, both in terms of geographic coverage and operational capabilities, such as having sufficient satellites to execute seamless handovers and to provide satellite diversity to support sharing with other NGSO systems. If an NGSO system applicant provides a reasonable showing regarding its initial business requirements, the Commission should permit the applicant to use that initial constellation as the benchmark for satisfying its sixth year milestone requirement and for the release of its bond. Satellite licensees that satisfy this requirement through the launch of their initial constellations will have obviously met the Commission’s underlying public policy goals in that scarce spectrum and orbital resources will not have been allowed to lie fallow.

With respect to the rest of the constellation, Boeing concurs with the Commission’s view that satellite licensees cannot have an indefinite period to launch the rest of their system. A

²⁵ Comprehensive Review of Licensing and Operating Rules for Satellite Services, IB Docket No. 12-267, *Second Report and Order*, FCC 15-167, ¶ 53 (2015) (citing Inquiry into the Development of Regulatory Policy in Regard to Direct Broadcast Satellites for the Period Following the 1983 Regional Administrative Radio Conference, Gen. Docket No. 80-603, *Report and Order*, 90 FCC 2d 676, 719, ¶ 114 (1982); MCI Communications Corporation, Application for Extensions of Time to Construct and Launch Space Stations in the Domestic Fixed-Satellite Service, *Memorandum Opinion and Order*, 2 FCC Rcd 233, 233, ¶ 5 (Com. Car. Bur. 1987); Norris Satellite Communications, Inc., Application for Review of Order Denying Extension of Time to Construct and Launch Ka-Band Satellite System, *Memorandum Opinion and Order*, 12 FCC Rcd 22299 (1997); Morning Star Satellite Company, L.L.C., Application for Authority to Construct, Launch, and Operate a Ka-band Satellite System in the Fixed-Satellite Service at Orbital Locations 62° W.L., 30° E.L., 107.5° E.L., and 147° W.L., *Memorandum Opinion and Order*, 16 FCC Rcd 11550 (2001)).

limit of three additional years, however, would be insufficient, possibly overwhelming the available launch capacity of commercial launch providers. Instead, given the fact that such an NGSO system licensee has already demonstrated that it is going to use its licensed spectrum and orbital resources to provide commercial services, it should be given sufficient time to launch the rest of its system on a measured basis. For example, Boeing would support allowing NGSO system operators that have satisfied their sixth year bond requirement to have another six years to launch the rest of their system. Further, as the NPRM, proposes, operators that do not complete the launch of the rest of their system should have their licenses amended by the Commission to restrict the total number of satellites to those already launched at that point rather than jeopardize the license.

Although the Commission may consider a total of 12 year (six years for bond release and another six years for the remaining constellation) to be lengthy, such a build out requirement would be significantly more aggressive than the build out requirements imposed by the Commission on licensees in other services. For example, the newly adopted rules for the Upper Microwave Flexible Use Service (“UMFUS”) permit licensees to provide mobile services to only 40 percent of the population in the licensed area by the end of their initial ten year license term.²⁶ As the Commission is aware, a terrestrial network can usually serve 40 percent of the population using a network that covers only a much smaller fraction of the licensed geographic area. In contrast, NGSO satellite licensees would be required to build out their entire systems by the end of their milestone period, be it 6, 9 or 12 years. Therefore, the Commission should recognize that adopting a two-step approach that requires the launch of an initial constellation by the sixth

²⁶ Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, GN Docket No. 14-177, *Report and Order and Further Notice of Proposed Rulemaking*, FCC 16-89, ¶ 206 (July 14, 2016).

year, and the completion of the constellation by the twelfth year would not be unreasonable or unprecedented. Instead, it would allow satellite licensees sufficient flexibility to launch their systems on a measured basis and in response to actual growth in customer demand.

XIII. THE COMMISSION SHOULD ELIMINATE ITS GLOBAL COVERAGE REQUIREMENT TO FACILITATE DIFFERENT BUSINESS APPROACHES

Boeing supports the Commission's proposal to eliminate its global coverage requirement for NGSO systems.²⁷ The Commission maintains geographic service rules to ensure that scarce orbital and spectrum resources are used to provide service that is available to all communities. Modern NGSO FSS systems using phased-array antennas and narrow beam-forming are very capable of sharing orbital and spectrum resources with other satellite and terrestrial systems and, therefore, do not preclude the use of such resources by other service providers.

Recognizing this fact, the Commission granted a waiver to O3b permitting its Ka-band NGSO FSS system to access the U.S. market without satisfying certain of the Commission's geographic service requirements.²⁸ The Commission's authorization for O3b stated that a waiver of the geographic service rules was granted because the O3b system "operates in an equatorial orbit as opposed to inclined orbit and as a result, due to look angle constraints, there is a limitation on the northernmost and southernmost latitudes that can be served by its system."²⁹ Thus, the Commission balanced the NGSO satellite operator's constellation design decision with

²⁷ See *NPRM*, ¶ 35.

²⁸ Authorization of O3b Limited, IBFS File Nos. SAT-LOI-20141029-00118 and D-SAT-AMD-20150115-00004 (Call Sign S2935) (first issued Jan. 22, 2015).

²⁹ *Id.*, ¶ 14. As O3b explained in its application, its system "is designed to focus bandwidth efficiently to areas where it is needed by the customer, rather than waste satellite power purporting to serve areas already adequately served or where there is no demand." O3b Limited, Petition for a Declaratory Ruling Granting Access to the U.S. Market for the O3b MEO Satellite System, IBFS File Nos. SAT-LOI-20141029-00118 and D-SAT-AMD-20150115-00004, at 16 (Oct. 29, 2014).

the policy desire to maximize U.S. coverage. The Commission should employ this same flexible approach with all NGSO FSS licensees by allowing each applicant to determine the appropriate global coverage area to optimize the utility and efficiency of its satellite system.

XIV. CONCLUSION

Boeing supports the Commission's proposals to facilitate additional flexibility in the operation of GSO and NGSO satellite systems in the bands allocated for FSS. Boeing, however, urges the Commission to refrain from adopting excessive regulatory mandates for NGSO FSS systems in the Ka-band or in other frequency bands that have not been demonstrated to be necessary to enable spectrum sharing with other systems.

Respectfully submitted,

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